AIRUSE-LIFE+: A harmonized PM speciation and source apportionment of ambient PM in five Southern European cities

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The AIRUSE-LIFE+ project aims at characterising similarities and heterogeneities in PM sources and contributions in urban areas from Southern EU. The main objective is to develop and test the efficiency of specific and non-specific measures to improve urban air quality. Here we report the synthesis results of the source apportionment of PM10 and PM2.5 conducted at 3 urban background sites (Barcelona, Florence and Milano, BCN-UB, FI-UB, MLN-UB) a sub-urban background site (Athens, ATH-SUB) and a traffic site (Porto, POR-TR). From January 2013 to February 2014 1047 PM10 and 1116 PM2.5 24h samples were collected simultaneously at the 5 cities, followed by the analysis of OC, EC, anions, cations, major and trace elements and levoglucosan. With this dataset USA-EPA PMF5 was applied individually and consensually for each city during a 5 days meeting during October 2014.

Road traffic (as sum of vehicle exhaust, vehicle non-exhaust and traffic-related secondary nitrate) is unequivocally the most important source of PM10 (at all sites) and PM2.5 (at MLN-UB, FI-UB, and POR-TR) while for PM2.5 at ATH-SUB and BCN-UB it is the second most important after secondary sulphate and secondary OC. The total annual mean contribution from road traffic to PM10 is commonly high (23-37%) at all AIRUSE monitoring sites varying, in absolute terms, from 4.8 µg/m^3 (ATH-SUB) to 12.8 µg/m^3 (POR-TR). Similarly, in PM2.5, traffic emissions increase concentrations by 22-40% (2.5-10.3 µg/m^3 as annual mean).

The second most important source of PM10 (20-26%) is secondary sulphate and OC at BCN-UB, FI-UB and ATH-SUB, while this only represents 10% of PM10 in POR-TR. The relative importance of this source is higher in PM2.5 (19-37% at SUB and UB sites and 13% in POR-TR), and increases from POR-TR (3.4 µg/m^3), ATH-SUB (3.8 µg/m^3), FI-UB (4.1 µg/m^3) to MLN-UB and BCN-UB (5.6 µg/m^3).

Biomass burning, BB, contributions vary widely, from 13-16% of PM10 in POR-TR and FI-UB, to 7% in ATH-SUB to <2% in BCN-UB. In PM2.5, BB is the second most important source in MLN-UB (21%) and in POR-TR (18%), the third one in FI-UB (21%) and ATH-SUB (11%), but again negligible (<2%) in BCN-UB. This large variability among cities is mostly due to the different percentage of BB for residential heating. In Barcelona natural gas is used as fuel in 96% of houses, while, in other cities, PM levels increase on an annual basis by 1-6 µg/m^3 due to this source.

Other significant anthropogenic sources are:

- Local dust, 10-12% of PM10 at SUB and UB sites and 18% at the TR site, revealing a contribution from road dust resuspension. In PM2.5 percentages decrease to 2-7% at SUB-UB sites and 15% at the TR site.
- Industries, mainly metallurgy contributing 4-11% of PM10 (5-12% in PM2.5), but only at BCN-UB, POR-TR and MLN-UB. No clear impact of industrial emissions was found in FI-UB and ATH-SUB.
- Remaining secondary nitrate, emitted from multiple sources such as industries, shipping and power generation contributes 2-10% PM10 and 1-6% of PM2.5.
- Natural contributions consist of sea salt (16% of PM10 in POR-TR but only 4-7% in the other cities) and Saharan dust (14% in ATH-SUB) but less than 4% in the other cities.

During highly polluted days, road traffic is the largest source of PM10 and PM2.5 at all sites (UB and TR): 35-45% to PM10 and 32-42% to PM2.5 except at ATH-SUB (9% and 11% respectively) due to the suburban location of this monitoring site (more distant from urban emissions). At ATH-SUB the highest contribution is from Saharan dust (52% and 45% respectively). Biomass burning is the second most important source during high pollution episodes at FI-UB, POR-TR and MLN-UB (25-30% of PM10 and 26-36% of PM2.5).

During those days, important contributions from industrial emissions in BCN-UB (17%-19%) and local dust in POR-TR (28-20%) are also present.

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